

## MEMORANDUM

Date: August 2, 2017

To: Mr. Boris Lipkin  
Deputy Director of Business  
Analytics and Commercial Implementation  
California High Speed Rail Authority  
700 L Street  
Sacramento, CA 95814

Re: Review of the 2016 Business Plan's Ridership and Revenue and Operations and Maintenance Costs for Phase 1 (Anaheim to San Francisco) of the California High-Speed Rail System to Assess Whether the Phase 1 Operations Will or Will Not Require an Operating Subsidy

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### Disclaimer

Project Finance Advisory Limited ("PFAL") and its subconsultants have performed an independent review of the operations and maintenance costs and ridership and revenue forecasts for the Phase 1 system as directed by the California High-Speed Rail Authority ("Authority") and as described in PFAL's executed Task Order 7 with the Authority dated June 1, 2017. This independent review of the operations and maintenance costs was performed using documents and information provided by the Authority (listed in the body of this Memo) and developed using currently accepted professional practices and procedures. PFAL, with the Authority's permission, has relied upon the accuracy and completeness of the documents and information provided by the Authority. While Authority assumptions relevant to PFAL's analysis were reviewed for reasonableness, the accuracy of the documents and information provided by the Authority and other publicly available material reviewed by PFAL in connection with this Memo were not independently verified by PFAL (except as otherwise explicitly described in this Memo). PFAL does not assume responsibility for verifying such material.

PFAL's opinions regarding the necessity of an operating subsidy as provided in this Memo are made with reference to the assumptions contained within the operations and maintenance cost review as well as the assumptions contained in the ridership and revenue review previously undertaken on behalf of the Authority.

This Memo does not serve as an accounting audit. Furthermore, this Memo should not be relied upon for any financing or investment decision. It is possible that there are other elements of risk associated with the Authority's Operations and Maintenance Cost Model and Ridership and Revenue Model beyond those presented. Any financial estimates, analysis or other conclusions in this Memo represent PFAL's professional opinion as to the general expectancy concerning events as of the evaluation date and are based solely upon the information provided by the Authority and PFAL's analysis described in this Memo. However, the accuracy of any financial estimate, analysis or other information set forth in this Memo is dependent upon the occurrence of future events, which cannot be assured. Additionally, these estimates and analyses rely upon the assumptions contained therein, the accuracy of which remains subject to validation, further refinement and the occurrence of uncertain future events. Estimates should not be construed as statements of fact. There may be differences between the projected and actual results because events and circumstances may not occur as expected.

The information and conclusions presented in this Memo should be considered as a whole. Selecting portions of any individual conclusion without considering the analysis set forth in this Memo as a whole may promote a misleading or incomplete view of the findings and methodologies used to obtain these findings.

# 1. EXECUTIVE SUMMARY

On June 1, 2017 the California High-Speed Rail Authority (“Authority”) directed Project Finance Advisory Limited (“PFAL”) and their subconsultant, First Class Partnerships Limited (“FCP”), to review the Phase 1 revenue and O&M cost projections to assess whether or not the planned passenger service to be provided by the Authority (or pursuant to its authority) for the Phase 1 system, will or will not require an operating subsidy within the definitions set out in Proposition 1A.

To form an opinion on the potential operating subsidy requirements for the Phase 1 system, PFAL reviewed the ridership, revenue, and operations and maintenance (“O&M”) cost projections’ assumptions, outputs, and validations for reasonableness of the forecasts (see Section 3 and Section 4, respectively). PFAL relied on similar documents and information for the Phase 1 revenue and O&M cost forecasts as the Central Valley to Silicon Valley (“Valley to Valley”) Line, and therefore was able to use some conclusions and analyses conducted in PFAL’s February 13, 2017 Valley to Valley Ridership and Revenue<sup>1</sup> and February 27, 2017 Valley to Valley Operations and Maintenance<sup>2</sup> memos to verify the model logic, construction, and validations for Phase 1. A discrete analysis of the Phase 1 system was still required due to the difference in ridership potential for the route between San Francisco and Anaheim as well as the increased cost of operating a larger system. Additional analysis for the Phase 1 system included review of the Phase 1 ridership’s exogenous growth (i.e. the growth that would occur in the absence of high-speed rail from population and economic growth), mode share, extent of induced demand, and load factor as well as the Phase 1 O&M cost assumption’s for staffing levels, fleet size, maintenance facilities, materials, and utilities.

As described in Section 3 and 4 of this Memo, we found that the Authority’s ridership and revenue and O&M cost projections were produced using sound methodology which reflects industry best practice. As is the nature of long term projections, PFAL found both upside and downside potential in the Authority’s revenue and O&M cost projections as summarized below and further detailed in Sections 3 and 4 of this Memo:

On ridership and revenue:

- The assumptions documented in the document titled “Ridership and Revenue Forecasting 2016 Business Plan: Technical Supporting Document”, (hereafter referred to as “Ridership and Revenue Documentation”), do form the basis for the revenue estimates;
- It was found the Authority’s revenue projections were developed using industry best practice and are reasonable for the purpose of our evaluation. We therefore used the Authority’s central case and identified potential upside and downside revenue scenarios to test the operating subsidy level. For the Phase 1 revenue central forecast, depending on the capacity of the system to carry higher ridership (described below) and the ability of the eventual operator to use normal commercial freedom around the customer product (including fare setting), we have assessed that Phase 1 revenue could be 29% higher than the Authority’s central forecast with a range of  $\pm 39\%$  at a 90% confidence interval;
- The above revenue and demand forecasts do not take into account the train passenger load capacity based on the Authority’s 2016 Business Plan and the system’s ability to meet the potential increased demand. The higher potential central forecasts imply very high passenger capacity load factors. If these forecasts are to be achieved, then some form of mitigation (discussed in para 3.1.3) will be required; and
- The above revised central forecast takes into account downside risks identified by PFAL for how time sensitivity and long access journeys are treated in the Authority’s ridership and revenue model. The downside risks identified by PFAL are offset by upside potential from the impact of a multiple fare revenue management system rather than average fare assumption currently used by the Authority’s model, the omission of bus passengers and non-Californians in the Authority’s ridership, exclusion of development impacts, and a lower

<sup>1</sup> “HSR14-65 Memo on Ridership and Revenue for Valley to Valley Line of the California High-Speed Rail System”. This memo was finalized on February 13 2017 as part of finalizing the analysis for the February 27, 2017 memo; there were no changes from the version of the memo that went to the Authority Board in December 2016.

<sup>2</sup> “Operations and Maintenance Costs for Valley to Valley Line and PCEP Scenario of the California High-Speed Rail System, and Whether Each Scenario Will Require an Operating Subsidy”. February 27, 2017.

level of induced demand being assumed in the Authority's forecasts than is generally seen with high-speed rail schemes that have been implemented.

On the O&M costing:

- The assumptions documented in the document titled "Operations and Maintenance Cost Model documentation 2016 Business Plan: Technical Supporting Document", (hereafter referred to as "Cost Model documentation"), do form the basis for the O&M cost estimates;
- The assumptions behind the cost level estimate and the associated contingency level are generally reasonable – although we did find some areas where the Authority's O&M model likely understates O&M costs and other areas where the model likely overstates O&M costs, and hence made some adjustments which are explained in this memo;
- Those adjustments that we were able to quantify are material to the cost level, with a negative impact in the order of \$46 million per annum when the Authority's high-speed rail operations reach steady state, which is approaching 6% of the cost base that the Authority has assumed for the Phase 1 service; and
- Although four potential upside adjustments were identified, the value of three of these could not reasonably be estimated (based on currently-knowable facts) so were not included in our cost and subsidy calculations. These items would offset some of the negative impacts that we note above and thus they are taken into account in our view of whether or not a subsidy is required.

For Phase 1 ridership and revenue PFAL adjustments, we found most of our previous conclusions still apply. However, we have found one area we believe should be re-analyzed as it related to the Phase 1 forecasts. We still consider the Authority's forecasts to be cautious, but by not quite as much as reported in our previous work. Previously we considered an appropriate central forecast of revenue to be 36% higher than the Authority's central forecast due to a number of conservative assumptions in the Authority's model; we now consider it to be 29% higher with a range of  $\pm 39\%$  at a 90% confidence interval. The central forecast for ridership is 23% higher, the remainder consisting of higher average yields resulting from a revenue management system. Note that this is a demand forecast; it does not take account of the capacity provided and the ability to carry the demand.

Whereas the PFAL adjustments to the Phase 1 O&M costs include quantifications in areas where the Authority's O&M model likely understates O&M costs, in areas where the model likely overstates O&M costs we primarily made qualitative assessments. This is because: i) three of the four potential overstated-costs areas are difficult to meaningfully quantify at this time, and ii) having adjusted costs for quantifiable upside and downside elements the analysis showed that in the Central Case revenue forecasts generally exceed the O&M cost forecasts so, from the point of view of assessing the need for an operating subsidy, it is not necessary to seek to quantify any further cost reductions that would only improve this position.

PFAL's adjustments to the Authority's O&M cost projections, as listed in Table 1 and further detailed in Section 4, relate to areas where the modelled O&M costs appear to differ from PFAL and FCP's benchmark data and experience and we believe the costs are likely to be higher than the Authority's estimates.

Table 1: PFAL O&M Adjustments

O&M Cost Items	Annual Cost In Full Ramp Up (\$million)
Overtime Payments	\$11.80
Retail System	\$26.68
Rail Maintenance Vehicle Costs	\$1.59
General Admin Establishment	\$0
Ongoing training – of which	\$2.66
- Drivers & Conductors	\$2.21
- Other staff	\$0.11
- Newly recruited Drivers	\$0.34
Cleaning Materials	\$2.66
Specialist IT Systems	\$0.43
Train Maintenance Water Consumption	\$0.20
<b>Total PFAL Adjustment</b>	<b>\$46.02</b>

The ridership and revenue PFAL adjustments made in Section 3 and the O&M PFAL adjustments made in Section 4 of this Memo were applied to PFAL’s scenario analysis of whether Phase 1 would require an operating subsidy. On the operating subsidy requirement, PFAL found that:

- The Authority’s modelled central case O&M cost, as defined by the Authority in the 2016 Business Plan, for the Phase 1 operation is substantially lower than the Authority’s modelled central case for revenue in each year of operation, i.e. each year of the full Phase 1 service. O&M costs under these conditions are 39% of forecast revenue during the post 2032 steady-state years;
- When evaluated against the additional PFAL O&M adjustments noted above and the Authority’s central case assumptions, it is highly likely that, Phase 1 of California High Speed Rail can be operated without subsidy on an ongoing basis as forecasted revenue will substantially exceed the adjusted modelled O&M costs in each year of Phase 1 operations assuming the Authority secures and negotiate an operator with similar terms and conditions presented;
- In the review of ridership and revenue, FCP and PFAL concluded there is a 90% probability that Phase 1 revenues would be at least 78% of the Authority’s central forecast. Our analysis shows that, even in the downside scenario of 78% of revenue, the Phase 1 service could operate without subsidy on an on-going basis. Furthermore, if in fact the ridership and revenue were only to reach 78% of projected levels, there would be other cost saving opportunities, for example, some services might be curtailed and on-board crew might be reduced; and
- Our conclusion that it is likely the Phase 1 service commencing in will be able to operate without ongoing subsidy is further supported by the following unquantified observations:
  - There may be various additional ancillary revenue opportunities, most notably from car parking, and also from on-board food and beverage sales. The Authority revenue forecasts assumed that ancillary revenues are only 1% of fare revenues, which is very cautious;
  - As stated above, we identified (but did not quantify) some areas in which the O&M costs may well turn out to be lower than the Authority’s projections

The content of this Memo is structured as follows: Section 1: Executive Summary; Section 2: Review Methodology; Section 3: Phase 1 Ridership and Revenue findings; Section 4: Phase 1 O&M findings; Section 5: Phase 1 Operating Subsidy Analysis; Section 6: Contingency; and Section 7: Conclusions.

## 2. REVIEW METHODOLOGY

PFAL and FCP previously produced memos on the Valley to Valley ridership and revenue and O&M cost forecasts dated February 13, 2017 and February 27, 2017, respectively. This Memo on the Phase 1 service extends the review previously performed to confirm whether the Phase 1 ridership and revenue and Phase 1 O&M cost forecasts are reasonable and robust to reach conclusions on whether the Phase 1 system may require an operating subsidy.

To do so, PFAL's team first reviewed what elements of the revenue and O&M costs for the Phase 1 system required further analysis in addition to the February 13, 2017 and February 27, 2017 memos. If PFAL found any areas within the revenue (see Section 2.2) or O&M costs (see Section 2.3) that appear to deviate from our professional experience, a PFAL scenario adjustment was noted. The adjustments were then evaluated in various scenarios to test whether an operating subsidy may be required for the Phase 1 system (see Section 2.4).

The following subsections detail the methodology used in PFAL's review for this Memo. PFAL and FCP's analysis of ridership and revenue, O&M costs, and operating subsidy are outlined in Sections 3, 4 and 5 of this Memo.

### 2.1 Review Assumptions

PFAL and FCP relied on the following definitions provide by the Authority for the purposes of this Memo:

- "Revenue" includes: fare box revenue (income from ticket sales), and Ancillary revenues (income the Authority may receive from sources related to the everyday business operations of the high-speed rail, including but not limited to on-board sales (e.g., sales of foods or sundries), station-related revenues, advertising, and revenues from leases of excess or non-operating right-of-way parcels or areas, as well as areas above or below operating rights-of-way or of portions of property not currently being used as operating rights-of-way). Ancillary income does not include unexpected or "one time" events.
- "Operating and maintenance cost" is defined as: the cost of running the trains and maintaining the infrastructure and rolling stock in a state of good repair. By definition, this category does not include capital asset renewal (or lifecycle) costs, which is the cost of replacing or refurbishing worn out components at the end of their useful life.
- "The planned passenger service to be provided by the Authority, or pursuant to its authority, will not require an operating subsidy" means: The consultant can indicate that, within a reasonable period of time after commencement of high-speed train operations on the segment or section evaluated, project revenues will reach an operating break-even point at which aggregate revenues up to that point in time equal Authority-borne operating and maintenance costs to that point in time and such revenues will continue to equal or exceed operating and maintenance costs thereafter.

Our analysis and conclusions rely on an underlying assumption that the project, as a whole, is delivered in accordance with the assumptions in the 2016 Business Plan. Of particular note to the conclusions of this review is the assumption that all start-up costs are fully covered outside of the O&M model as the O&M Cost model is based on revenue service and the premise that a fully operational railway is available from day 1 of service commencement (with testing, commissioning, and trial running having occurred before that).<sup>3</sup> Likewise, all rolling stock mid-life overhauls, as described in the Authority's Cost Model Documentation, are categorized as lifecycle costs and not included as an O&M cost subject to review of this analysis. Also important to note is that we assumed the train service timetable (journey times and capacity) is delivered broadly in line with the 2016 Business Plan.

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<sup>3</sup> PFAL's review is not an audit and does not make any opinions on the accounting principles or practices assumed by the Authority as it pertains to the treatment of capitalization in its documentation.

Based on the information provided to us by the Authority, our Phase 1 analysis covered the period from 2029 to 2039. The Authority's modelling of both ridership and revenue and O&M costs assumed that the Valley to Valley service would operate from 2025 until 2028 and that the Phase 1 service would begin in 2029, with a combined eight year ramp-up period from 2025 through 2032. Having already examined the Authority's ramp-up methodology during our review of the Valley to Valley service and finding it reasonable, we did no further examination of the ramp-up for this memo. For the assessment of whether the Phase 1 service would require an operating subsidy, our primary focus was on the period from start of Phase 1 in 2029.

There are a number of outstanding procurements that could change the findings and assumptions of this memo. These include the procurement of an early operator, long-term operator, rolling stock, and rail infrastructure provider. This review is based on the preliminary assumptions provided by the Authority in regards to the early operator, long-term operator and rolling stock, which are still under procurement and development by the Authority. As mentioned above, this Memo assumes any interface risks associated with the procurements and initial operating periods for the early operator, long-term operator, rolling stock, and rail infrastructure provider will be addressed ahead of the start of this analysis within the Authority's ramp-up period.

For our review of the O&M costs and of the sensitivities, we built a "synthesized" model to test the accuracy of the implementation of the stated O&M assumptions. This "synthesized" model did not, nor was used to develop independent or separate O&M cost forecasts. Its only purpose was as a tool to review the reasonableness of the Authority's O&M Cost Modelling methodology. The "synthesized" model relied on the Authority's inputs and information.

## 2.2 Phase 1 Ridership and Revenue Review Methodology

The review of Phase 1 ridership and revenue was undertaken in a manner consistent with PFAL's Valley to Valley ridership and revenue review memo dated February 13, 2017. However, there was no need to repeat work undertaken as part of the Valley to Valley Line review where the item had not changed. Notably, the in-depth examination of the Cambridge Systematics ("CS") forecasting model construction and logic was not required (the same CS model was used for Phase 1 ridership forecasts as for the Valley to Valley Line).

The Valley to Valley Line Ridership and Revenue review covered:

1. Model construction and development; i.e. is the structure of the model appropriate for the purpose it is being used? Did the development process lead to appropriate enhancements being made to the model?
2. The assumptions underpinning the model; i.e. where parameter values have been estimated using statistical techniques and/or calibrated to observed data, were appropriate and industry standard practices followed? Where it was not possible to estimate or calibrate parameter values, have appropriate methodologies been used to derive values? Are the values reasonable compared to those seen in similar circumstances elsewhere?
3. The outputs from the model, including how sensitive the model was to various inputs; i.e. are elasticities to fare and time and values of times reasonable when compared to those observed elsewhere? Are the forecast mode shares and levels of demand reasonable when compared to those observed elsewhere with HSR?
4. Model validation; i.e. does the model accurately reproduce current travel patterns? Does it forecast any observed changes in demand that result from previous changes in characteristics of modes that are modeled?

The first, second and fourth of the above tasks did not require repeating as the model is unchanged in structure, assumptions (parameters values) and validation. Our observations on the CS model structure, assumptions and validation remain as in our review of the Valley to Valley Line, along with their associated downside risks, upside potential and general uncertainty, although in some cases the impact of these on the forecasts is different from that estimated in the Valley to Valley Line review.

The review for Phase 1 ridership and revenue therefore focused on the outputs from the model in the context of the Phase 1 service; i.e. are the outputs plausible taking account of the service proposed to be operated? The Phase 1 review examined:

- The exogenous growth from 2025 (year assumed for Valley to Valley Line) to 2029 (year assumed for Phase 1). Exogenous growth was identified and compared with the input growth in population, additional growth being related to economic growth (experience elsewhere is that HSR ridership increases with higher economic activity both for business and recreation trips).
- Mode shares implied by the model for Phase 1 and consistency with HSR journey times and other relevant factors. Mode shares were compared with those observed elsewhere with HSR, while taking account of the Authority's view that California is a unique market for HSR. The impact of different journey times was examined.
- Which existing modes HSR demand is expected to be attracting from. As with the Valley to Valley Line review, the impact of HSR on travel by other modes was examined and compared with experience elsewhere.
- The level of induced demand was also examined and compared with that found with the Valley to Valley Line forecasts and also experience elsewhere.

As part of the review of the Valley to Valley Line, the likely risks and potential upsides were quantified for both the Valley to Valley Line and Phase 1. During that review the focus had been on the Valley to Valley Line; the current review has therefore re-examined the risks and upside potential for Phase 1 and in a few cases made some changes.

As with the Valley to Valley Line review, the examination of ridership and revenue initially assumes there is adequate capacity to carry the forecast ridership. A similar exercise was performed (reported in Section 3.1.3) to determine there was adequate capacity to carry the Phase 1 forecasted ridership.

## 2.3 Phase 1 O&M Cost Review Methodology

In the February 27, 2017 Valley to Valley Operating Subsidy Memo, we described the methodology for reviewing the O&M costs for the Valley to Valley Line. This review established that:

- all of the key documents were consistent with each other
- the inputs and assumptions from which the O&M costs were derived were reasonable especially given the current level of model development
- we could replicate the modelled O&M costs, to a reasonable degree of accuracy, from the available documentation

These findings were carried into the Phase 1 analysis as baseline assumptions.

To verify that Phase 1 can operate without subsidy, PFAL and FCP used a 'top-down' review to validate and/or challenge the provided Phase 1 O&M costs built up from:

1. An assumed service specification (consistent with that used for the ridership and revenue forecast)
2. A set of assumptions for resourcing the operation (staffing levels, fleet size, maintenance facilities, materials, utilities, etc.)
3. A set of unit cost assumptions for costing the operating resources
4. An assumed ramping up from partial to full operation over the first eight years of operation

The methodology employed by the team to perform the "top-down" review involved analyzing the cost derivation process to verify that the Phase 1 O&M inputs generate results consistent with the modelled Phase 1 outputs. The synthesized model created for the February 27, 2017 Valley to Valley Operating Subsidy Memo analysis was used to verify the Phase 1 outputs. This was achieved by using the Phase 1 inputs and then comparing the outputs from the synthesized model with those from the Authority's O&M Model.

The task then took a 'bottom-up' review of these four sets of assumptions with respect to whether:

- They are 'necessary and sufficient' (i.e. they cover all areas of O&M required for a high-speed railway, and do not include any areas that are not required)
- The values used are appropriate for a high-speed railway in California

The methodology employed by the team to complete the "bottom-up" review was to verify whether the modelled outputs for the Phase 1 operation were necessary and sufficient by reviewing them against good operating practices and comparable international experience. The costs included in the O&M cost model were benchmarked against international comparator railways where possible using key indicators and ratios.

Where required, we have made adjustments to the O&M costs based on international comparators and professional judgement.

## 2.4 Scenario Testing

Comparison of the Central Case Revenue forecast to the O&M costs, even with the cost adjustments identified, resulted in a significant operating surplus. This being the case, we carried out some sensitivity analysis employing large changes to cost and revenue to test whether this changed the conclusions of the memo.



### 3. PHASE 1 RIDERSHIP AND REVENUE FINDINGS

This section describes the main findings for the Phase 1 ridership and revenue using the review methodology described in Section 2.2.

#### 3.1 Ridership & Revenue Analysis

##### 3.1.1 EXOGENOUS GROWTH AND SOURCE OF HSR DEMAND

The Authority’s growth in the ‘No Build’ demand from 2025 to 2029 is 4.8%, which is the increase in ridership expected in the absence of high-speed rail due to factors such as population and economic growth. The assumed growth in population of California over the same period is 2.8%, implying that 2.0% growth is due to economic factors. This is 0.5% per annum – a modest figure as experience shows that HSR demand increases with higher economic activity. Table 2 below shows the source of the forecast HSR demand for seven major markets.

Table 2: Source of HSR Demand - Phase 1 (derived from CS response to Q D3.1 for 2029 Phase 1)

Market Pair	HSR Demand (Annual Ridership 2029 Millions)	From Auto	From Air	From Conventional Rail	Induced*
Bay Area (MTC) – San Joaquin Valley (SJV)	4.132	91.1%	1.6%	2.0%	5.2%
Bay Area (MTC) – Southern California (SCAG)	6.259	52.1%	41.2%	0.5%	6.2%
Bay Area (MTC) – San Diego (SANDAG)	0.743	41.5%	52.9%	0.3%	5.4%
Sacramento (SACOG) – San Joaquin Valley (SJV)	0.244	98.8%	2.0%	1.6%	-2.5%
Sacramento (SACOG) - Southern California (SCAG)	0.954	55.7%	39.2%	0.3%	4.8%
San Joaquin Valley (SJV) - Southern California (SCAG)	5.576	87.0%	3.0%	5.2%	4.8%
San Joaquin Valley (SJV) - San Diego (SANDAG)	0.492	83.7%	9.6%	2.8%	3.9%

\* Induced demand is people who in the absence of HSR would not make the trip by any mode

The HSR demand forecast for some Phase 1 markets is significantly higher than for Valley to Valley Line; this is principally where a direct service is provided in Phase 1, notably to Los Angeles. However, the proportions abstracted from the different modes are comparable. The majority of HSR ridership comes from auto, and air, with the latter only an important source on the longer distance market pairs. The dominance of auto as a source of demand is unusual for HSR and reflects the current dominance of automobiles for travel within California. As noted in the Valley to Valley Line review, existing intercity bus traffic is excluded from the CS analysis. Induced demand is below 7% in all market pairs (and in one case slightly negative demand). This is very low; induced demand on new HSR systems is typically in the range of 20% to 50% of total trips.

### 3.1.2 MODE SHARE

Table 3 shows Phase 1 mode shares once HSR is in place, and is based off the CS Model.

Table 3: Mode Shares – Phase 1 (derived from CS response to Q D3.1 for 2029 Phase 1)

Market Pair	HSR	Auto	Air	CVR
Bay Area (MTC) – San Joaquin Valley (SJV)	9.3%	89.3%	0.5%	1.0%
Bay Area (MTC) – Southern California (SCAG)	27.9%	54.1%	17.8%	0.2%
Bay Area (MTC) – San Diego (SANDAG)	19.0%	46.9%	34.0%	0.2%
Sacramento (SACOG) – San Joaquin Valley (SJV)	1.6%	97.3%	0.2%	0.9%
Sacramento (SACOG) - Southern California (SCAG)	11.8%	66.6%	21.4%	0.2%
San Joaquin Valley (SJV) - Southern California (SCAG)	15.5%	81.8%	0.9%	1.7%
San Joaquin Valley (SJV) - San Diego (SANDAG)	13.6%	81.1%	4.4%	0.9%

Generally these forecast mode shares look reasonable, with large increases compared to Valley to Valley Line being seen where a direct service is provided in Phase 1. As previously commented, auto retains the largest single share in all markets reflecting the California (and wider US) culture of preparedness to make long auto trips.

In the Valley to Valley review, the share between HSR and air was commented on in the context of model validation. While accepting that all markets are different, we present in Figure 1 **Error! Reference source not found.** a comparison of the forecast shares with those found in Europe and NE Corridor of USA. It is important to note that all the observed shares on the graph are uncertain in that the catchment areas of airports and rail stations are not well defined, and we are reliant on data that cannot be fully verified.

Figure 1: HSR Share of HSR/Air Market in California (forecast) Compared to NE USA and Europe

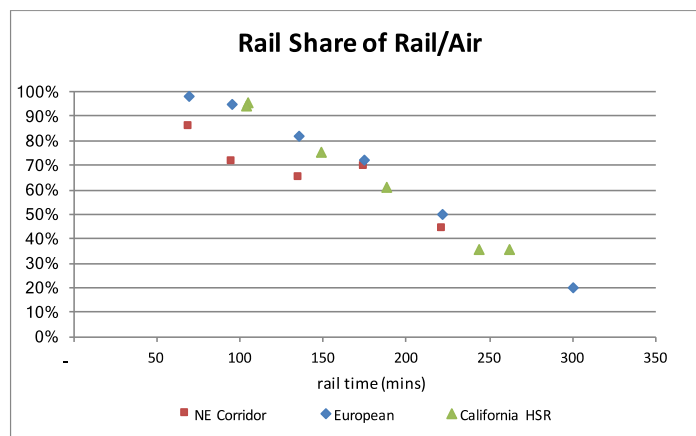


Figure 1 shows that in all cases the rail share reduces as rail time increases. The California forecasts are remarkably similar to the European observed shares and also to NE Corridor at journey times above 3 hours. At shorter rail times, the forecast for California are 15% - 25% higher than NE Corridor equivalents but very close to those found in Europe. Overall the graph gives confidence in the forecasts, with perhaps some modest concern regarding the forecasts at shorter rail journey times; critical here is what the NE Corridor data represents – we suspect (but have no way of verifying) that the NE Corridor air passengers may include passengers transferring

onto long haul flights; as the California HSR forecasts are based on survey results with true origin and destination, this is not the case for the Phase 1 forecasts.

### 3.1.3 *LOAD FACTOR REVIEW*

We have examined the ridership forecasts and compared them with the capacity provided by the proposed timetables in 2029 and in 2040. Based on this review of the Authority's forecasts and load factors, they appear generally in line with international benchmarks meaning that the forecast ridership and revenue can in the main be achieved from the service plan assumed. However, there are some high implied load factors for short distances in later years and it might require either pricing action on short distance flows, or modest additional train services to address this; these are typical of the sorts of action a responsible train operator would take in response to emerging travel demands.

To capture the additional revenue that the PFAL/FCP adjusted central forecast would produce, the Authority or the train operator would need to take some steps such as adjusting the service plan by adding more trains or running some trains as double consists, and/or changing the fare structure. We believe that these adjustments could be made (indeed we believe the planned fleet could provide an additional 10% seats and there is flexibility in the contract to purchase additional trains); while this may result in some additional O&M costs, those costs would be substantially outweighed by the revenue that would be generated. If no actions are taken, then the PFAL/FCP forecast would not be fully achievable as some demand and revenue would be lost because trains would be too full.

### 3.1.4 *ANCILLARY REVENUES*

PFAL and FCP's Memo on Ridership and Revenue only looked at fare revenues. The Authority's business plan assumes that ancillary revenues would be 1% of fare revenues, which we view as conservative. The O&M cost estimates assumed no provision of on-board food and beverage services, and had no specific provision for the O&M costs of parking facilities. We understand that the Authority is planning to install automatic ticket gates at most or all stations. There will also be substantial parking lots at most stations. There is provision for four customer-facing staff on all trains. There do therefore seem to be substantial opportunities to increase revenues, with much lesser cost impacts, by using some staff to sell food and beverages on trains. The ridership and revenue forecasts did assume that passengers would need to pay to park at stations, but did not explicitly include any amount of revenue this would generate in the forecasts; this is clearly a conservative assumption. International experience on similar corridors is that ancillary revenues, including parking revenues and margins on food and beverage sales, can exceed 5% of total revenues. We did not include any ancillary revenue in the analysis below because we were primarily looking at various downside sensitivity (i.e., stress-test) scenarios.

## 3.2 Phase 1 Ridership & Revenue Conclusions and PFAL Adjustments

Similar to PFAL's Valley to Valley ridership and revenue review, PFAL made an assessment of the central forecast and the range of uncertainty for Phase 1 revenue for the purposes of sensitizing the operating subsidy analysis. We reiterate that this is not an exact science, but involves judgement based on our considerable experience forecasting HSR (and other rail and transportation schemes and services) in many different contexts, some, but not all, of which were implemented and financed. We have sought to be as objective as possible in our judgement, basing it on as much evidence as we could gather, and listening carefully to the opinion and analysis of the model developers. The opinion below is our independent view as to an outcome and range to be considered. The numbers below are in no way intended to replace or supplant the work performed by CS.

We considered the forecasts made by CS for Phase 1 and identified a number of areas where we considered that alternative assumptions or forecasts could be made. These were categorized as one of:

- General – that is areas that create uncertainty in the forecasts but no clear bias as to the direction of uncertainty;
- Downside risk – that is we consider that for this reason the forecasts are most likely overestimated;
- Upside potential – that is we consider that for this reason the forecasts are most likely underestimated.

### 3.2.1 GENERAL

The first general area we consider is the mode constant for HSR as similarly identified by CS. Our assessment is to the same as that in the Valley to Valley Line review. This risk contributed 83% of the overall risk in CS risk analysis. We agree that this is an important risk area and the most influential on the modeled results. CS took an extreme view on the upper and lower bound of this risk; provided the forecasts are adjusted to take account of the other factors (as detailed below), we believe that evidence from other HSR means that this range can be reduced. Rather than calculate the risk based on a mathematical model, we prefer, in this context, to consider the outcome of other HSR and achieved forecasts, mode shares, etc. and hence derive a realistic assessment of the likely range as +/- 25%.

The issues of survey data and validation result in risk as identified in the Valley to Valley review. We consider the impact on the central forecasts to be neutral, but the risk to be +/- 20% as we did for the Valley to Valley Line review.

The failure to distinguish car access and egress remains a risk. Car access is mainly park and ride, although there is also some drop off and taxi. Car egress is a combination of taxi, car rental and some pick up. The model treats these with the same parameter values (albeit different costs and different mode constants); given the very different nature of park and ride (the dominant choice for access) from those available for egress this introduces potential risk. As in Valley to Valley Line review we consider the risk to be +/- 10%.

### 3.2.2 DOWNSIDE RISK

As in the Valley to Valley Line review, we have combined the risk associated with low sensitivity to time with that of long car access as the two risks interact. For Phase 1 it is mainly the latter that is relevant (any error in the former has been addressed by the judgement taken on the HSR mode constant (see above). While the extent of long car access is much less in Phase 1 than in the Valley to Valley Line, there remains some risk here; relatively long car access might explain why US high speed rail (in NE Corridor) appears to have a slightly lower mode share compared to air than European equivalents (see Table 4). We take the view that for Phase 1 the risk results in a 10% reduction in central forecasts (compared to 25% for Valley to Valley Line), and have reduced the range associated with this factor from +/-20% to +/-10% to reflect that it only relates to a smaller part of the market.

### 3.2.3 UPSIDE POTENTIAL

We have identified greater upside potential than downside potential in our review of the Phase 1 ridership and revenue forecasts.

We discussed the use of a single fare by origin/destination pair for all market segments in the Valley to Valley Line review. We consider that the omission of the air fare differential results in a small downside risk (about 5%), but this is more than compensated by an upside potential for the omission of market fares on HSR (about 10%). The range associated with this is +/- 10%. The Authority recognizes the use of a single fare is a conservative assumption and will be optimized when the early operator is selected.

Omitting current users of intercity buses from the model dataset will have added some risk to the forecasts, but the biggest impact is that such passengers are assumed all to remain with bus and none to transfer to HSR – this constitutes upside potential. Experience in Europe is that substantial share of intercity bus passengers will switch to HSR, if competitive fares are offered. The central forecasts increases by 5% with a range of +/- 5%.

The omission of non-Californians from the forecasts is clearly an upside potential as identified by CS. Certainly some tourists will use HSR. There will also be trips made by people from outside California using HSR for business, leisure, and Visiting Friends and Relatives (“VFR”). The upside to the central forecasts is 7.5% with a range of +/- 2.5%.

The assumption that there is no change in land use/ development as a result of HSR is an upside potential, even assuming no actual intensification of land development. Existing housing and offices can (and would be expected to) be occupied in the future by those more likely to be interested in HSR than current occupiers. We propose increasing the central forecasts by 10% for this, with a range of +/- 10%; we note that it might take five years or longer for the appropriate development changes to occur.

The level of induced demand in the model is low by comparison with observed HSR elsewhere, and we propose to increase the central forecast by 10% with a range of +/-10%. This is lower than might be implied by HSR comparators elsewhere, but we consider that some of the induced demand reported elsewhere may relate to development issues as covered in the previous paragraph.

### 3.2.4 QUANTIFYING THE RISKS AND POTENTIAL

As in the Valley to Valley Line review we have brought all the above risks and potential upsides together into a single table and calculated the overall risk.

Table 4 sets out our view of the overall risk interpreted as a revised central forecast as a factor on the Authority’s forecast and the range of risk around it.

*Table 4: Quantification of Risk and Upside Potential*

PFAL Ridership Adjustments	Impact on Central Forecast Phase 1	Range	Comment
<b>Mode constant for HSR</b>	1 (neutral)	±25%	This risk identified by CS (with larger range)
<b>Survey and validation</b>	1 (neutral)	±20%	Mainly based on observed ridership elsewhere
<b>Fares</b>	1.05 (upside)	±10%	-5% for air fares; +10% for HSR fares
<b>Intercity bus</b>	1.05 (upside)	±5%	Market not included in CS model up to 10% increase in ridership
<b>Non California</b>	1.075 (upside)	±2.5%	Market not included in CS model 5% to 10% increase in ridership
<b>Development impacts (including induced commuting)</b>	1.1 (upside)	±10%	
<b>Time sensitivity/ Long access</b>	0.9 (downside)	±10%	Impacts flows with long access journeys or greater journey times than presented in SP; factor takes into account that many flows not significantly affected
<b>Car rental</b>	1 (neutral)	±10%	No impact on central forecast, but failure to model egress separately from access increases risk
<b>induced Demand</b>	1.1 (upside)	±10%	Some HSR services have induced considerably more than this
<b>Combined Revenue Factors</b>			
Central	1.29	±39%	
Lower	0.78		
Upper	1.80		

The table shows that our central forecast for Phase 1 revenue (in current prices) is 29% higher than that of CS, with a range of ±39% (i.e. a 90% confidence that revenue will be at least 78% of CS forecast and no more than 180% of CS forecast). These estimates are based on professional judgement and experience.

It is important to note that these estimates are based on the assumptions that were used by CS. If trains are faster or slower, more or less reliable, or priced lower or higher than assumed, the ridership and revenues will be different. Likewise the estimates are based on estimates of California population, employment and incomes, and assumptions as to the cost and characteristics of competing modes.

## 4. PHASE 1 O&M COST FINDINGS

This section describes the main findings for the Phase 1 O&M cost forecasts using the review methodology described in Section 2.3.

### 4.1 Phase 1 O&M Analysis

#### 4.1.1 RESULTS OF TOP-DOWN REVIEW

In the top down review we used the Authority's O&M Costing methodology with inputs from the Phase 1 service specification and the Authority's documented assumptions in a synthesized model to verify the inputs generate results consistent with the Phase 1 outputs. The synthesized model was able to generate O&M costs that were consistent with those in the Authority's 2016 Business Plan. As expected, there are some non-material differences between the Authority's results and our results which can be explained by the fact that some of the detailed workings of the Authority's model are not fully replicated in our work and the synthesized model was only high level analysis opposed to a detailed model created by the Authority.

By comparison of the Authority's O&M Cost model and the PFAL and FCP synthesized cost model, the team was able to verify that the O&M costs presented by the Authority are indeed consistent with applying the assumptions of wages and other unit costs to the operating resources, both in terms of total cost and the breakdown by category and by Labor, Material and Other.

We concluded that the Authority's O&M Cost projections are entirely consistent with the assumed:

1. service specification/timetable, which is in turn consistent with that used for the ridership and revenue forecast
2. levels of resourcing required for Phase 1 operation (staffing levels, fleet size, maintenance facilities, materials, utilities, etc.)
3. the unit cost assumptions used for costing the operating resources
4. the ramping up from partial to full operation over the first eight years of operation

#### 4.1.2 RESULTS OF BOTTOM-UP ANALYSIS

The bottom-up analysis focused on the Inputs, Assumptions, Calculations and Outputs of the Authority's O&M Cost model as shown in blue in Figure 1 in Section 2.3.1 of our February 27, 2017 Valley to Valley Memo.

- **Model inputs:** Certain elements of the Authority's O&M Cost model inputs are taken directly from the service specification (e.g. numbers of stations, maintenance of equipment facilities, maintenance of infrastructure facilities, daily trains run). These are shown in slide 3 of "2016 Business Plan - PH1 OM Results - for PFAL" document provided by the Authority. The team verified that the specified 78 trainsets, 4 Maintenance of Equipment (MOE) facilities, 5 Maintenance of Infrastructure (MOI) facilities and 13 stations are necessary and sufficient for the operation of the proposed service specification of 98 full round trips per day on the 540 mile-long Phase 1 Line plus 18 trips per day each way in the early morning and late evening.
- **Assumptions:** Our work on the February 27, 2017 Valley to Valley Memo confirmed that the cost model documentation contained an appropriate set of generic assumptions, specific assumptions and headings that covered the necessary top-level cost areas for running a high-speed railway under the Valley to Valley and PCEP scenarios. In this Phase 1 analysis we reviewed the assumptions to confirm their continued validity in the context of the Phase 1 operation.
- **O&M Costs:** In our work for the February 27, 2017 Valley to Valley Memo, we identified a number of upside cost savings and downward cost adjustments. For this review of the Phase 1 service, we reviewed the previously identified adjustments and concluded that, with some minor amendments noted below, the

adjustments should be carried forward into the Phase 1 analysis. That analysis is described in section 4.2.1 below.

## 4.2 Phase 1 O&M Conclusions and PFAL Adjustments

In our February 27, 2017 Valley to Valley Memo, we established the internal consistency of the documents and the logic of the cost derivation model for the Valley to Valley and PCEP scenarios. We found that the consistency of the documents and logic of the cost derivation model remained true for the Phase 1 service.

PFAL and FCP noted both upside cost saving opportunities (Section 4.2.1) and cost increase possibilities (Section 4.2.2) to the Authority's O&M costs. For purposes of the analysis on whether the Phase 1 system would need an operating subsidy, we focused mostly on the areas where costs could be higher than the Authority's projections (since if the system does not require a subsidy under those conditions then the upside cost savings are not necessary for the analysis).

### 4.2.1 UPSIDE O&M COST SAVINGS OPPORTUNITIES

In the February 27, 2017 Valley to Valley Memo we identified four areas as presenting upside cost savings opportunities to the Authority. For the Phase 1 service we found that these cost saving opportunities remained valid. In addition, we identified a potential opportunity to fine tune the fleet size which is discussed below.

1. Staff Optimization
2. Cost of Shared Facilities
3. Removal of Terminal Control Facilities from the model
4. Greater Efficiency from Train and Infrastructure Inspection Technology

Regarding the above items, item 3 was quantified by the Authority at \$12.8 million for Phase 1, but for items 1, 2 and 4, quantification is not possible at this time for the following reasons:

- **Staff Optimization:** The level of staff optimization possible will be driven by the service pattern and standards, location of facilities and the labor practices of the operator. Neither of these positions are currently fixed and therefore at this time we can only point to a potential, but unquantified benefit.
- **Cost of Shared Facilities:** The Authority has chosen to take a conservative assumption on these costs in the O&M Cost model by including the entire cost of shared facilities and we assume that the final position will be the subject of a commercial negotiation between the parties. We have not challenged the Authority's assumption on this issue nor would it be appropriate to quantify a specific amount in advance of any commercial negotiation.
- **Greater Efficiency from Train and Infrastructure Inspection Technology:** As stated above, we believe that the potential cost reduction for MOI from this technology to be material. The quantum of any saving is largely dependent on the capability of on train equipment deployed and approved changes to the currently mandated FRA inspection regime which we understand is a point of discussion between the Authority and the FRA. It would not be appropriate for us to quantify this impact in advance of on train monitoring equipment choices being made and the conclusion of discussions with the FRA.

PFAL and FCP identified an additional Phase 1 O&M upside cost saving opportunity with for the Phase 1 fleet size optimization. The Authority has assumed a fleet size of 78 trains which, based on the iteration of the timetable reviewed and the O&M cost model documentation are deployed as shown in Table 5 below:



*Table 5: Fleet Size*

Required for TT	62
Maintenance allowance (10%)	7
Standby units	2
<b>Trains required each day:</b>	<b>71</b>
Planned Fleet Size	78
Trains required each day	71
<b>Potential to reduce fleet size:</b>	<b>7</b>

As can be seen from Table 5, the current view of fleet deployment would allow for a reduction in the overall size of the fleet of up to seven units. Our view is that reducing the fleet size would result in a nominal capital cost reduction to the Authority and a nominal train maintenance annual cost reduction not quantified in PFAL’s adjustments.

In Section 3.1.3 above, we discussed the possibility of load factors above those forecast in the Authority’s Central Case. Clearly, staying with a train fleet of 78 units and the deployment shown in Table 5 above would provide the Authority with sufficient rolling stock to provide additional capacity and mitigate the negative impact of higher load factors on the Authority’s ability to achieve the entire central revenue forecast that we see.

From the documentation reviewed and discussion with the Authority we understand that the train fleet for purposes of these forecasts is assumed to be delivered over a 10-year period but that the procurement contract will allow flexibility in the final fleet size and timing beyond that singular assumption. This is a sound approach that will allow the Authority to fine tune the fleet size in the light of emerging ridership and operating experience.

**4.2.2 DOWNSIDE O&M COST ADJUSTMENTS**

In the February 27, 2017 Valley to Valley Memo, we identified a number of areas in the O&M Cost model where costs may be higher than currently accounted for in that model:

- Overtime Payments
- Retail System
- Rail Maintenance Vehicle Costs
- G&A Establishment
- Ongoing Training
- Cleaning Materials
- Train Maintenance Water Consumption
- Specialist IT Systems
- Capability to Recover Failed Trains

In addition, we commented on the costs of facilities management of stations, depots and offices which did not seem to be allowed for in the O&M cost model.

In general, we believe the issues identified and detailed in the February 27, 2017 Valley to Valley Memo remain true for the Phase 1 service. There is one exception to this general point which is explained below. In addition, we have reviewed the O&M cost of ticket retailing and have concluded that factoring up the value used in the Valley to Valley memo for this item gives a value at the high end of expectations which is also explained in the text below Table 6.

Table 6 below contains three columns that show (from left to right):

1. The O&M adjustment stated for each item in the February 27, 2017 Valley to Valley Memo
2. The quantum of each adjustment as calculated for the Phase 1 service using the Phase 1 synthesized cost model
3. The value of the adjustment recommended for the Phase 1 service taking all relevant factors into account

Table 6 quantifies the PFAL and FCP opinion regarding the impact of the adjustments described above.

*Table 6: Upward Cost Adjustments to the Modeled O&M Cost*

O&M Cost Items	Annual Cost adjustment in Full Ramp-Up (\$m)		
	TO-6 (V to V)	TO 7 (derived for Phase 1)	TO 7 (proposed for Phase 1)
Overtime Payments	9.40	11.80	11.80
Retail System	6.00	26.68	26.68
Rail Maintenance Vehicle Costs	1.59	1.59	1.59
General Admin Establishment	2.96	10.34	-
Ongoing training	1.58	2.66	2.66
- Drivers & Conductors	0.41	2.21	2.21
- Other staff	1.11	0.11	0.11
- Newly recruited Drivers	0.07	0.34	0.34
Cleaning Materials	1.02	2.66	2.66
Train Maintenance Water Consumption	0.08	0.43	0.43
Specialist IT Systems	0.20	0.20	0.20
<b>Total PFAL Adjustment</b>	<b>22.84</b>	<b>56.36</b>	<b>46.02</b>

The two items which have not been factored up in line with the increase of activity between the Valley to Valley scenario and the Phase 1 service are the O&M cost of retail systems and the increment on the modelled General & Administration establishment. The logic for these exceptions is shown below:

- **O&M Cost of Retail Systems:** The \$26 million shown in the table is a high-side estimate which through early operator engagement and a greater definition of plans should be capable of reduction. Our adjustment is also based on UK operator experience which may not ultimately be similar to the business model agreed by the Authority, early operator and operator of the Phase 1 system, but retained the high-side estimate for conservativeness in this review. We note the Authority's previous comments that the cost of retail systems will be capital spend that falls outside of the scope of this memo. However, ticket retailing will incur significant O&M costs relating to software, hardware and potentially third party commission payments that are not yet explicitly included in the O&M cost model. The Authority is in the fortunate position of being able to deploy a new ticketing retail system as opposed to inheriting a legacy system and we would expect it to contain the following components:
  - Inventory / reservation system;
  - Yield management system;
  - Booking engine;
  - Web site (including mobile version);
  - Mobile app;
  - TVMs;
  - CRM/loyalty system; and,
  - Validators/ATBs.

These components will incur O&M costs and this, together with the assumption that the cost of the website will be fully offset by advertising revenue with which we do not concur, leads us to conclude that O&M costs in this area will be higher than currently forecast.

- **Increment on G&A Establishment:** The O&M cost model calculates the G&A establishment as 10% of frontline headcount. In the February 27, 2017 Valley to Valley Operating Subsidy Memo for the Valley to Valley scenario we stated that the resultant 91 staff was too low for the range of functions to be covered and the effective management of a geographically dispersed workforce. As a result we stated that a figure of 12.5% was more appropriate for the calculation of the G&A establishment.

For the Phase 1 service, the 10% factor results in a G&A establishment of 335 which is appropriate for the size and geographically dispersed nature of the business. Therefore, in the context of the Phase 1 service as a whole the O&M cost model produces an acceptable output for the G&A establishment and no further incremental adjustment is recommended.

#### 4.2.3 *POTENTIAL UPWARD COST PRESSURES ON MAINTENANCE OF EQUIPMENT (MOE) COSTS*

In the course of reviewing the Phase 1 service we have noted that the Authority's assumption of a balanced day/night work pattern will not deliver the required overnight services. This may result in an upward pressure on the MoE costs. However in the round the Authority's total staff assumptions are adequate provided that the shift patterns are adjusted to meet train down-time availability for servicing (i.e. about 35% day and 65% night work). We expect that these potential cost pressures can all be managed and mitigated through the development of operating plans and through early operator engagement. We are not therefore suggesting that the O&M model be adjusted at this stage. Typical issues for development with the early operator are listed below; 1-6 are all manageable within the Authority's staffing assumptions with item 7 being covered by the O&M contingency provision.

1. **Back Office Maintenance Staffing:** Within the maintenance teams there is provision for materials staff but no explicit provision for back office technical staff needed to download and analyze train and infrastructure condition data from onboard and fixed systems. We would expect these staff to analyze train performance during the day (12:00-20:00), setup the unscheduled work (faults/defects to be cleared) per train, work with the operations team to agree where trains are placed overnight to protect the morning services, organize to put the materials needed per train in the right place so that these are available on arrival this ensuring an efficient turn-round. We have assumed that this resource (circa 100) will come from the general 10% admin staff provision and will be assigned to the MoE organization. This assumption should be validated as the model is developed.
2. **Centers of Excellence:** To optimize depot operational efficiency it is suggested that the HMF should not carry out any 48 hour or monthly examination work but rather concentrate on quarterly maintenance, overhaul work and wheel turning, i.e. only undertake scheduled work requiring the train out of service for periods of time exceeding an overnight stop. This will serve to improve other depots' staff utilization by giving greater critical mass (staffing/skills) to the overnight work and at the same time make it possible to operate the HMF as production facility.
3. **Depot Layout:** Train down-time (i.e. when work can be done) is of paramount importance; when designing the depot layout the number of train moves needs to be minimized to ensure the productivity inherent in the Authority's labor costs can be achieved.
4. **Train cleaning:** This is particularly important for the product image. Trains that remain in stations overnight need to be vacuum cleaned throughout (as though they were on a depot) as well as cleaning of the at-seat tables, toilets and internal windows as needed. Where trains are cleaned in stations overnight it is assumed there will be no CET (Controlled Emission Toilets) evacuation facilities; to support this strategy the train technical specification must call for a 3 day "CET tank range"; this must be supported by a maintenance plan that ensures trains return to depot every 48 hrs for CET tank evacuation.
5. **1.2 Million Mile Overhaul:** Cumulative replacement of walkway carpeting and seat covers and other high-wearing internal furniture and any eternal paint repairs needs to be part of this work plan.

6. **600K Mile Bogie Overhaul:** Our experience suggests that that a program of wheel profile maintenance (cutting little and often) will result in a wheel life of 900-1000kmiles. This has driven other operators to move to a bogie overhaul at this interval where all wearing components are exchanged at the same time. While this increases the materials costs there is a saving of one bogie overhaul in three, this should roughly balance out and still remain within the Authority's cost modelling. If the cumulative train overhaul is done at the same time this gives just the one train out of service and since the work is easily split up the train downtime can be managed to 5 days. The impact of working in this way reduces the need for two lifting roads at the HMF as well as reducing the out-of-service need for overhaul to one train at any one time.
7. **Contingency for Unforeseen Expenditure:** In addition to a general contingency fund it may be prudent to consider creating a specific contingency fund to cover such items as: incidents / accidents that trigger fleet modifications, mandatory modifications due to changes in law or regulation and out of course train repairs such as pantograph destruction in a de-wirement or internal vandalism. Note: We have assumed that the Authority will have comprehensive insurance cover across the business for, among other things, damage to property or the fleet sustained in normal operations.

## 5. PHASE 1 OPERATING SUBSIDY ANALYSIS

To evaluate whether the Phase 1 service will require an operating subsidy, we conducted a series of sensitivities. We first looked at the Authority’s base-case figures (Table 7), then adjusted the cost figures based on our view of the upward and downward O&M adjustments that could be quantified (Table 8), and then ran two additional sensitivity tests looking at the robustness of the forecasts in light of potential pessimistic situations (Table 9 and Table 10).

### 5.1 Authority’s Phase 1 Service Central Case

The forecast of revenue and O&M cost for operating the Phase 1 service through 2035 as presented by the Authority is shown in Table 7. As indicated in Section 3 and 4, we have verified that the revenue and O&M costs are consistent with the Authority’s documented assumptions.

The forecasts shown in Table 7, as presented by the Authority, indicate that the revenue from the Phase 1 service will exceed the O&M costs in 2029, and will continue to do so thereafter. Therefore, the forecasts indicate that the high-speed railway will be able to operate without operating subsidy from 2029 onwards if the Authority’s assumptions materialize. This is shown in the table below:

*Table 7: Phase 1 Service Operating Surplus / Deficit (Authority's Central Case)*

Authority Figures (in 2015 \$)	Phase 1 Operation						
	2029	2030	2031	2032	2033	2034	2035
Farebox Revenue	1,104	1,365	1,632	1,906	2,188	2,219	2,250
O&M Cost	730	756	791	818	847	855	858
<b>Surplus/(Deficit)</b>	<b>374</b>	<b>610</b>	<b>841</b>	<b>1,088</b>	<b>1,342</b>	<b>1,364</b>	<b>1,392</b>

In Section 4 we highlighted upside areas where we believe the Authority’s costs could be reduced (quantifying one of them), and quantified downside costs from our review of the O&M model and documentation. The costs that we were able to quantify have been added to the Authority’s modeled O&M cost to create a PFAL Adjusted O&M Cost. Taking the PFAL Adjusted O&M Cost together with the Authority’s revenue numbers in Table 8 results in a conclusion that revenue from the Phase 1 service will exceed O&M costs throughout its operation (from 2029). In making these calculations we have not adjusted the revenue forecasts; if we were to use the PFAL adjusted central revenue forecast, then the profitability of the service would increase.

*Table 8: Phase 1 Service Operating Surplus / Deficit (with PFAL Adjustments to O&M costs)<sup>4</sup>*

(in 2015 \$)	Phase 1 Operation						
	2029	2030	2031	2032	2033	2034	2035
Farebox Revenue	1,104	1,365	1,632	1,906	2,188	2,219	2,250
Authority O&M cost	730	756	791	818	847	855	858
Authority Quantified Upside adjustment	(13)	(13)	(13)	(13)	(13)	(13)	(13)
Total PFAL downside Adjustment	44	34	38	42	46	46	47
PFAL Adjusted O&M Cost	761	777	816	847	880	888	892
<b>Surplus/(Deficit)</b>	<b>343</b>	<b>588</b>	<b>816</b>	<b>1,059</b>	<b>1,308</b>	<b>1,331</b>	<b>1,358</b>

## 5.2 Sensitivity Testing for Phase 1 Service Operating Subsidy

Sensitivity testing has been undertaken to assess the robustness of the conclusion that no operating subsidy will be required. The sensitivity tests were carried out using the adjusted O&M costs (i.e. including the downside items).

In the first test, Scenario 1 shown in Table 9, we used the PFAL Adjusted O&M Cost in Table 8 and raised the contingency to 40% to reflect the top of the range recommended by the Department of Transportation. This was meant to test scenarios that are even more pessimistic than those that we tested in the Valley to Valley Line analysis from the February 27, 2017 memo. Even in this case, revenue exceeds costs throughout Phase 1 operations.

*Table 9: Sensitivity Scenario 1 - O&M Cost Contingency Raised to 40%*

(in 2015 \$)	Phase 1 Operations						
	2029	2030	2031	2032	2033	2034	2035
Authority Revenue	1,104	1,365	1,632	1,906	2,188	2,219	2,250
PFAL Adjusted O&M Cost with 40% contingency	852	870	914	949	985	995	999
<b>Surplus/(Deficit)</b>	<b>252</b>	<b>495</b>	<b>718</b>	<b>957</b>	<b>1,203</b>	<b>1,224</b>	<b>1,251</b>

In the second test, Scenario 2 shown below in Table 10, we assessed the impact of taking revenue at the low end of the 90% confidence interval reported in Section 2, which was 78% of the CS forecast for Phase 1. For O&M costs, we started with the PFAL Adjusted O&M Costs in Table 8, and then factored savings from retail and ticketing systems costs due to the decrease in ridership assumed in Scenario 2. In this downside scenario, revenue still exceeds O&M costs throughout Phase 1 operations.

<sup>4</sup> Rounding accounts for slight differences in summation in this table and in the scenarios that follow in sections 5 and 6.

*Table 10: Sensitivity Scenario 2 - 78% of Revenue forecast and PFAL Adjusted O&M Costs*

(in 2015 \$)	Phase1 Operations						
	2029	2030	2031	2032	2033	2034	2035
Revenue at 78% of forecast	861	1,065	1,273	1,487	1,707	1,731	1,755
PFAL Adjusted O&M Cost	761	777	816	847	880	888	892
Call Center & CC Commission Saving	(15)	(15)	(15)	(15)	(15)	(15)	(15)
Retail System Savings	(6)	(4)	(4)	(5)	(6)	(6)	(6)
Total Scenario 2 Adjusted O&M Cost	740	758	797	827	859	867	871
<b>Surplus/(Deficit)</b>	<b>121</b>	<b>306</b>	<b>476</b>	<b>659</b>	<b>848</b>	<b>863</b>	<b>884</b>

## 6. CONTINGENCY

This section sets out PFAL’s comments on the Authority’s O&M contingency in relation to the question of whether or not a subsidy is required.

### 6.1 Revenue

Section 3 of this memo discusses the appropriate level of the central case for revenue, and looks at the confidence interval around this case. As noted elsewhere, PFAL considers the central case to be higher than the Authority has projected leading to a variance around that central case at the 90% confidence level of -22% and +80%. The resulting lower level of 78% is used in the PFAL sensitivity tests on the requirement for subsidy, discussed further in Section 5.

### 6.2 The Authority’s O&M Cost Contingency

The contingency on the O&M costs is structured in the same way for Phase 1 as it was for the Valley to Valley. It includes an allocated element, based on confidence ratings provided by Authority staff on the budgets they put forward, and an unallocated element to account for certain project-wide uncertainties. The Authority benchmarked this total contingency proportion against those of other high-speed railways and applied the Department of Transportation’s guidance (including conducting a Monte Carlo simulation of the probability of several cost over-run scenarios).

#### 6.2.1 ALLOCATED CONTINGENCY

The Authority describes a bottom up approach to setting contingency for each line item where by the staff who prepared the budget provided relative uncertainty levels for their estimates. These were then converted to contingency at levels scaled between 15% and 35%, and these amounts were added to the respective budget lines. The allocated contingency was set at a constant proportion across all of the years in the business plan and so applies equally to the respective Valley to Valley and Phase 1 line items. This scale was selected with reference both to the Department of Transportation’s suggested range of 20%-40% and with the variance to budget for O&M of several other high speed railways.

As an internal budgeting process, this approach seems appropriate at this stage for allocated contingency, where estimates are being refined but not yet market tested.

The allocated contingencies applied in practice range from 16.25%-25% and are about 20% of the underlying O&M costs. The Authority recognizes in the Business Plan that these estimates are subject to biases in both directions, both over-confidence such as unawareness of omissions, and inclusion of costs that appear likely to be optimized as the project develops.

#### 6.2.2 UNALLOCATED CONTINGENCY

The Authority has applied an unallocated contingency of 5%, of O&M costs (excluding allocated contingency) based on consistency with assumptions in the Authority’s capital and lifecycle cost estimates.

#### 6.2.3 TOTAL O&M COST CONTINGENCY

At 25%, the sum of the allocated contingency and the unallocated contingency falls within the Department of Transportation range of 20%-40%.

Rather than double check the uncertainty of the allocated contingency on individual line items or benchmark further the level of unallocated or total contingency, we looked at a very simple sensitivities. We compared a “downside”



scenario for revenue to a conservatively adjusted O&M forecast and found there was no requirement for subsidy once steady state was reached.

We also conducted a test of putting the overall contingency to upper end of the Department of Transportation's suggested range, and this too indicated no on-going need for a subsidy.

#### *6.2.4 PFAL COMMENTS ON THE O&M COST CONTINGENCY*

As noted in the February 27, 2017 Valley to Valley Operating Subsidy Memo, the Authority is presently reviewing its insurance budget. We, therefore, did not review this costing, which can vary substantially, nor the extent of the coverage. Changes to the risk events covered or to the minimum claim size will impact the budget.

Furthermore, in the context of a procurement exercise or a wider budgeting decision where the surplus funds will be apportioned to other uses (such as costs of this project that lie outside the O&M definition of this exercise <sup>5</sup> or other rail or infrastructure projects), there may be pressures to set the contingency at a higher level in order to increase budget certainty.

Although we are not recommending an alternate level for the contingency at this intermediate stage in the budget development process, we note that the Department of Transportation guidance for this stage of the project puts forward a range for the overall contingency that goes up to 40%, and the Authority's total contingency for Phase 1 is about 25%. We have run a stress test on the O&M costs that shows a scenario in which the Authority could bring the total contingency up to this upper limit and still operate without subsidy. We have also suggested above that the Authority consider setting up a separate fund for unexpected one-off events (as distinct from cost overruns or pricing variance). This would be for items such as fleet modifications required following incidents or changes in regulation that fall outside of normal insurance (see Section 4.2.3 point 7).

We recognize that the Authority will continue to review and amend the contingency levels as the project develops.

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<sup>5</sup> Among these are costs falling outside of insurance or below the deductible such as train repairs following incidents, adaptations to regulatory changes or other variances from Authority business case assumptions, major train overhauls, debt service, contractor risk contingency and profit, and rail authority contract oversight.

## 7. CONCLUSIONS

Our analysis of the Authority's Phase 1 O&M cost projections, associated documentation and comparison with the Phase 1 ridership and revenue forecast has reached the following conclusions with regard to the Phase 1 service:

1. The Authority's central case modeled O&M cost for the Phase 1 service from 2026 (before any PFAL adjustment) is lower than the forecast revenue in each year of Phase 1 operation and thus there is no requirement for an operating subsidy according to the Authority's central case assumptions.
2. When the Authority's O&M cost is modified to include PFAL's adjustments that can be quantified for the Phase 1 service, O&M costs remain lower than the forecast revenue in each year of Phase 1 operation, thus maintaining the conclusion that Phase 1 will likely not require an operating subsidy under these adjusted assumptions.
3. In a PFAL revenue downside scenario taking revenue at the low end of the 90% confidence interval reported in Section 2, which was 78% of the Authority's forecast for Phase 1, and taking PFAL's adjusted O&M costs, O&M costs remain lower than the forecast revenue in each year of Phase 1 operation, thus maintaining the conclusions that Phase 1 will likely not require an operating subsidy under these adjusted assumptions.
4. At steady state, the O&M costs are forecasted to be 39-41% of revenue in 2033, the first year of steady state operations, depending on whether the Authority's costs or the PFAL adjusted costs are used.
5. We conclude that based on our analysis and review of the Authority's central case assumptions and PFAL's additional scenario testing of revenue and O&M costs, there is a high degree of likelihood that the Phase 1 service commencing in 2026 can operate without subsidy. Furthermore, we note that there are actions the Authority can take to further bolster the system's operating performance by mitigating the possible impact of the more negative revenue scenarios on the levels of surplus revenue.

These findings and conclusions are based on the Authority's current assumptions and information, which PFAL concluded were reasonable, and are subject to change as the Authority procures an operator and rolling stock.



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